**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of: Steen Ørsted Andersen

Application No.: 10/797,375

Filing Date: March 9, 2004

For: METHOD AND APPARATUS FOR PRODUCING A HIGH RESOLUTION IMAGE

Confirmation No.: 4468

Patent No.: 7,327,388 B2

Patent Date: February 5, 2008

Attorney Docket No.: 81421-4038

**REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. § 1.322**

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Patentee hereby respectfully requests the issuance of a Certificate of Correction in connection with the above-identified patent. The correction is listed on the attached Form PTO-1050. The correction requested is as follows:

Title Page:

Item (57) **ABSTRACT**, line 3, after "apparatus" delete "is". This change is requested to correct an error of a clerical nature and does not involve a change that would constitute new matter or require reexamination.

Column 15:

Line 38 (claim 8, line 1 of the formula), change each occurrence of " $V_o$ " to -- $V_0$ -- .

Line 39 (claim 8, line 2 of the formula), after " $X,q_{(2)}Y)-(F_{3,3})*$ ", begin a new paragraph.

Line 40 (claim 8, line 3 of the formula), after " $(G_{-1,-0})*I_a(n_{-1}X_A,m_{-0}Y_A)-(G_{-0,-1})$ ", begin a new paragraph.

Line 41 (claim 8, line 4 of the formula), after " $X_A,m_{-1}Y_A)-(G_{-1,-1})*I_a(n_{-1}X_A,m_{-1}Y_A)$ ", begin a new paragraph.

Line 53 (claim 8, line 19), change " n-n,**31** m'th " to -- n-n,m-m'th --.

Support for the above changes appear in application claim 11.

Column 16:

Line 49 (claim 10, line 25), change " mourned " to -- mounted --. Support for this change appears in application claim 5.

Column 18:

Line 8 (claim 14, line 2 of the formula), after " $X,q_{(2)}Y)-(F_{3,3})*$ ", begin a new paragraph.

Line 9 (claim 14, line 3 of the formula), after " $(G_{-1,-0})*I_a(n_{-1}X_A,m_{-0}Y_A)-(G_{-0,-1})$ ", begin a new paragraph.

Line 10 (claim 14, line 4 of the formula), after " $X_A,m_{-1}Y_A)-(G_{-1,-1})*I_a(n_{-1}X_A,m_{-1}Y_A)$ ", begin a new paragraph.

Support for the above changes appear in application claim 16.

Line 45 (claim 17, line 1), after "claim", change " **13** " to -- **12** --. Support for this change appears in application claim 19, which is dependent from application claim 13, now patent claim 12.

A fee of $100 is believed to be due for this request. Please charge the required fees to Winston & Strawn LLP Deposit Account No. 50-1814. Please issue a Certificate of Correction in due course.

Respectfully submitted,

2/14/08

Date

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**Customer No. 28765**

212-294-3311

# UNITED STATES PATENT AND TRADEMARK OFFICE
# CERTIFICATE OF CORRECTION

PATENT NO. : 7,327,388 B2 

APPLICATION NO. : 10/797,375

DATED: : February 5, 2008

INVENTOR(S) : Andersen

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Title Page:
Item (57) **ABSTRACT**, line 3, after "apparatus" delete "is".

Column 15:
Line 38 (claim 8, line 1 of the formula), change each occurrence of " $V_o$ " to -- $V_0$ -- .
Line 39 (claim 8, line 2 of the formula), after " $X,q_{(2)}Y)-(F_{3,3})*$ ", begin a new paragraph.
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Line 45 (claim 17, line 1), after "claim", change " **13** " to -- **12** --.

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US007327388B2

(12) **United States Patent**
**Andersen**

(10) **Patent No.: US 7,327,388 B2**
(45) **Date of Patent: Feb. 5, 2008**

(54) **METHOD AND APPARATUS FOR PRODUCING A HIGH RESOLUTION IMAGE**

(75) Inventor: **Steen Ørsted Andersen**, Roskilde (DK)

(73) Assignee: **DeltaPix ApS**, Måløv (DK)

( * ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 737 days.

(21) Appl. No.: **10/797,375**

(22) Filed: **Mar. 9, 2004**

(65) **Prior Publication Data**

US 2004/0169735 A1 Sep. 2, 2004

**Related U.S. Application Data**

(63) Continuation of application No. PCT/DK02/00589, filed on Sep. 11, 2002.

(30) **Foreign Application Priority Data**

Sep. 11, 2001 (DK) .............................. 2001 01326

(51) **Int. Cl.**
*H04N 5/225* (2006.01)

(52) **U.S. Cl.** .................................................. **348/219.1**

(58) **Field of Classification Search** ............. 348/219.1
See application file for complete search history.

(56) **References Cited**

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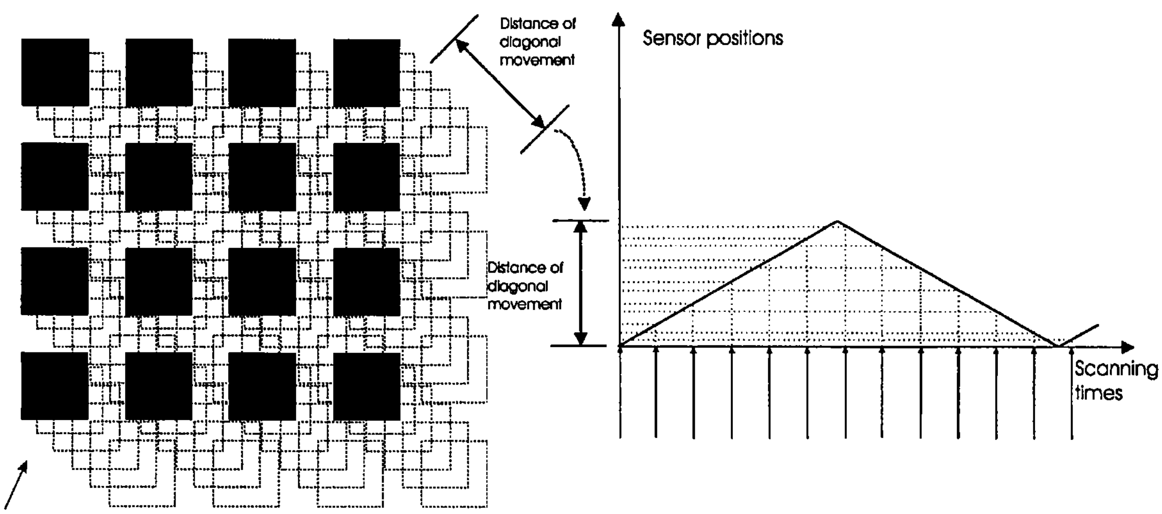
*Assistant Examiner*—Adam L Henderson
(74) *Attorney, Agent, or Firm*—Winston & Strawn LLP

(57) **ABSTRACT**

A method and apparatus serves for converting a low resolution first image to a high resolution second image. The apparatus includes a light sensor for receiving incident light radiated from a scene. The light sensor has a number of cells, each defining a predetermined area, and is arranged for cyclically scanning the low resolution first image a number of times while at least one driver moves the light sensor an identical number of times in at least one direction. For each step the light sensor is moved a distance corresponding to the extent of the area covered by the cell in the direction of movement while the total distance covered corresponds to the extent of the cell in the movement direction. Thereby a number of subareas are defined. A computer serves to establish a representation of the high resolution second image by calculating the representation of the received incident light from the scene at each subarea by software program. Thereby, a higher resolution and a better image quality is obtained than previously known.

**17 Claims, 11 Drawing Sheets**

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4. The method of claim 3, which further comprises calibrating the method by:

moving the light sensor to a number of calibration positions by applying known energy values to the at least one driver,

obtaining a signal representing the incident light radiated from the scene at each calibration position, and

calculating a reference value representing the distance of the movement of the light sensor by comparing the different numbers of known energy values with the different signals representing the incident light radiated from the scene.

5. The method of claim 1, which further comprises:

stepwise moving the light sensor by means of at least one driver relative to the light radiating scene,

recording the immediate position of the light sensor by at least one position sensor generating output representing the said sensor position,

sending the output to a computer having a software program for calculating control values on basis of the received output, and

sending signals representing the calculated control values to the at least one position driver for bringing this to drive the light sensor in such a way that the steps of movement as function of the scannings defines a predetermined curve.

6. The method of claim 1, wherein the light sensor is moved in a system of x-y coordinates and moved at least in one of the x-y directions of this system or in the direction of a cell of the light sensor.

7. The method of claim 1, which further comprises minimizing the influence of errors in previous calculated or estimated values by means of a digital filter.

8. The method of claim 7, wherein the digital filter uses several values from several cycles to compute a filter output value by the following formula

$V_0$

$$I_a(nX_A,mY_A)=(F_{1,1})^*V_o(p_{(1)}X,q_{(1)}Y)-(F_{2,2})^*V_o(p_{(2)}X,q_{(2)}Y)-(F_{3,3})^*\ldots-(F_{A,A})^*V_0(p_{(A)}X,q_{(A)}Y)-(G_{-1,-0})^*I_a(n_{-1}X_A,m_{-0}Y_A)-(G_{-0,-1})^*I_a(n_0X_A,m_{-1}Y_A)-(G_{-1,-1})^*I_a(n_{-1}X_A,m_{-1}Y_A)\ldots-(G_{-n,-m})^*I_a(n_{-n}X_A,m_{-m}Y_A),$$

where:

$I_a(nX_A,mY_A)$ is the light radiation value of the n,m'th element in the new $X_A,Y_A$ matrix to be calculated,

$I_a(n_{-1}X_A,m_{-0}Y_A)$ is the previous calculated element of the n−1,m'th element of the new $X_A,Y_A$ matrix,

$(G_{-1,-0})$ is the belonging predetermined filter value,

$I_a(n_{-0}X_A,m_{-1}Y_A)$ is the previous calculated element of the n,m−1'th element of the new $X_A,Y_A$ matrix,

$(G_{-0,-1})$ is the belonging predetermined filter value,

$I_a(n_{-n}X_A,m_{-m}Y_A)$ is the previous calculated element of

n-n, m-m'th the n−n,31 m'th element of the new $X_A,Y_A$ matrix,

$(G_{-n,-m})$ is the belonging predetermined filter value,

$V_0(p_{(1)}X,q_{(1)}Y)$ is the measured and stored output value of the p, q'th element in the physical sensor matrix overlapping the n,m'th element in the new calculated $X_A$, $Y_A$ matrix from the first position,

$(F_{1,1})$ is the belonging predetermined filter value,

p,q are calculated from n/A and m/A,

$V_0(p_{(A)}X,q_{(A)}Y)$ is the measured and stored output value of the p,q'th element in the physical sensor matrix overlapping the n,m'th element in the new calculated $X_A,Y_A$ matrix from the A'th position,

$(F_{A,A})$ is the belonging predetermined filter value, and

p,q are calculated from n/A and m/A.

9. A method for converting a low resolution first image produced by a light sensor for receiving incident light radiated from a scene to a high resolution second image, whereby the light sensor is constructed as an array or matrix having a number of cells with each cell defining a predetermined area, which method comprises:

cyclically scanning the first image a number of times;

simultaneously moving the light sensor with the scanning stepwise an identical number of times relative to the light radiating scene in at least one direction thereby defining a number of subareas, such that the total distance covered during movement of the light sensor corresponds to the extent of the cell or to the extent of the cell plus a distance defined by or to a neighbor cell in the at least one movement direction, and

establishing a representation of the high-resolution second image by calculating the representation of the received incident light from the scene at each subarea,

wherein the light sensor is moved a distance for each step corresponding to the extent of the area covered by the cell plus a distance defined by or to the neighbor cell minus the extent of the area of the smallest subarea to be calculated in the direction of movement, divided with the number of scanning times.

10. A method for converting a low resolution first image produced by a light sensor for receiving incident light radiated from a scene to a high resolution second image, whereby the light sensor is constructed as an array or matrix having a number of cells with each cell defining a predetermined area, which method comprises:

cyclically scanning the first image a number of times;

simultaneously moving the light sensor with the scanning stepwise an identical number of times relative to the light radiating scene in at least one direction thereby defining a number of subareas, such that the total distance covered during movement of the light sensor corresponds to the extent of the cell or to the extent of the cell plus a distance defined by or to a neighbor cell in the at least one movement direction, and

establishing a representation of the high-resolution second image by calculating the representation of the received incident light from the scene at each subarea,

wherein incident light received from the scene is represented as a number of pixels at each subarea, and the method further comprises substituting at least some of the pixels with information of the position of the light sensor mounted on a sensor frame, thereby providing an identifiable coding of the position of the light sensor mourned on the sensor frame as a low resolution first image. mounted

11. An apparatus for converting a low resolution first image to a high resolution second image, comprising:

a light sensor for receiving incident light radiated from a scene to a high resolution second image, whereby the light sensor is constructed as an array or matrix having a number of cells, with each cell defining a predetermined area;

means for bringing the apparatus cyclically to scan the first image a number of times by means of the light sensor;

means for moving the light sensor simultaneously with the scanning stepwise by an identical number of times relative to the light radiating scene in at least one direction of movement, whereby the total distance covered during the movement of the light sensor corresponds to the extent of the area covered by the cell in the direction of movement or to the extent of the area

covered by the cell in the direction of movement plus a distance defined by or to a neighbor cell in the direction of movement, divided by the number of scanning times in order to define a number of subareas, and

means for establishing a representation of a high resolution second image by calculating the representation of the received incident light from the scene at each subarea.

**12**. An apparatus for converting a low resolution first image to a high resolution second image, comprising:

a light sensor for receiving incident light radiated from a scene to a high resolution second image, whereby the light sensor is constructed as an array or matrix having a number of cells, with each cell defining a predetermined area;

a frame for movably mounting the light sensor;

an activator for bringing the apparatus cyclically to scan a low resolution first image a number of times by means of the sensor;

at least one driver for simultaneously moving the light sensor with the scanning stepwise an identical number of times relative to the light radiating scene in at least one direction, whereby the total distance covered during the movement of the light sensor corresponds to the extent of the cell or to the extent of the cell plus a distance defined by or to a neighbor cell in the at least one movement direction to define a number of subareas; and

at least one position sensor for recording the immediate position of the light sensor relative to the frame and sending output representing the position to a computer having a software program for calculating control values on basis of the received output and sending signals representing the calculated control values to the at least one position driver for bringing this to drive the light sensor in such a way that the steps of movement as function of the scannings defines a predetermined curve in a coordinate system,

wherein a representation of the high resolution second image is established by calculating the representation of the received incident light from the scene at each subarea by means of the formula:

$$I_a(z)=V_0*A/a(z)-\Sigma I_a(n) \text{ for } n=1 \text{ to } n=N,\ n\neq z$$

where

N=the number of subareas into which each cell is split,

n=the index for subareas in the light sensor cell,

a=the area of a subarea of the light sensor cell,

$V_0$=the output signals from the light sensor cells,

$I_a$=the computed light radiation received by the subarea a,

z=the subarea to be used for calculation, and

A=the area of the light sensor cell.

**13**. The apparatus of claim **12**, which further comprises a digital filter arranged for minimizing the influence of at least one error in the value.

**14**. The apparatus of claim **13**, wherein the digital filter uses several values from several cycles to compute a filter output value by the following formula

$$I_a(nX_A,mY_A)=(F_{1,1})*V_0(p_{(1)}X,q_{(1)}Y)-(F_{2,2})*V_0(p_{(2)}X,q_{(2)}Y)-(F_{3,3})*\ldots-(F_{A,A})*V_0(p_{(A)}X,q_{(A)}Y)-(G_{-1,-0})*I_a(n_{-1}X_A,m_{-0}Y_A)-(G_{-0,-1})*I_a(n_0X_A,m_{-1}Y_A)-(G_{-1,-1})*Ia(n_{-1}X_A,m_{-1}Y_A)\ldots-(G_{-n,-m})*I_a(n_{-n}X_A,m_{-m}Y_A),$$

where,

$I_a(nX_A,mY_A)$ is the light radiation value of the n,m'th element in the new $X_A$, $Y_A$ matrix to be calculated,

$I_a(n_{-1}X_A,m_{-0}Y_A)$ is the previous calculated element of the n−1,m'th element of the new $X_A$, $Y_A$ matrix,

$(G_{-1,-0})$ is the belonging predetermined filter value,

$I_a(n_{-0}X_A,m_{-1}Y_A)$ is the previous calculated element of the n,m−1'th element of the new $X_A$, $Y_A$ matrix,

$(G_{-0,-1})$ is the belonging predetermined filter value,

$I_a(n_{-n}X_A,m_{-m}Y_A)$ is the previous calculated element of the n−n, m−m'th element of the new $X_A$, $Y_A$ matrix,

$(G_{-n,-m})$ is the belonging predetermined filter value,

$V_0(p_{(1)}X,q_{(1)}Y)$ is the measured and stored output value of the p,q'th element in the physical sensor matrix overlapping the n,m'th element in the new calculated $X_A$,$Y_A$ matrix from the first position,

$(F_{1,1})$ is the belonging predetermined filter value,

p,q are calculated from n/A and m/A,

$V_0(p_{(A)}X,q_{(A)}Y)$ is the measured and stored output value of the p,q'th element in the physical sensor matrix overlapping the n,m'th element in the new calculated $X_A$, $Y_A$ matrix from the A'th position, and

$(F_{A,A})$ is the belonging predetermined filter value, and p,q are calculated from n/A and m/A.

**15**. The apparatus of claim **12**, wherein the computer is provided with a software program for establishing a representation of the high resolution image by calculating the representation of the received incident light from the scene at each subarea.

**16**. The apparatus of claim **12**, wherein the at least one driver is an electromechanical device or a piezoelectric-element.

**17**. The apparatus of claim **13**, 12 wherein the at least one driver comprises a coil rigidly mounted on a base frame and an anchoring means mounted on the sensor frame, with the sensor frame being moveably mounted on the base frame, and the anchoring means being actuated by an attractive force induced by the coil, thereby pulling the anchor toward the coil.

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